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AUTHOR	Sunal, Dennis W.; And Others
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ABSTRACT

The purpose of this study was to determine if intervention instruction in encoding processes affects novice teacher problem solving ability in educational contexts of varying levels of complexity. It sought to determine the effects of intervention training in nine specific encoding processes, prerequisite to effective problem solving, on novice teacher performance in observing and making higher quality decisions in planning and teaching classroom lessons. The cognitive structure level of the novice teacher was also studied to determine its effects on the quality of professional performance. The subjects of the study were senior year preservice education majors at a large eastern university. A detailed description is given of the procedures followed in the intervention process used in the instruction received by the experimental group. These procedures were intended to increase the complexity of awareness, including perceiving, conceiving, reasoning, and judging, through adaptation to the environment and assimilation of information. A discussion of the results indicates support for the hypothesis that teacher education courses and inservice training focusing at least partially on basic encoding processes can increase novice teacher effectiveness in basic teaching and problem solving skills. (JD)

TEACHER THINKING: EFFECTS OF INTERVENTION INSTRUCTION ON BASIC TEACHING AND PROBLEM SOLVING SKILLS

DENNIS W. SUNAL
MARY E. HAAS
MARTIN SALTZ
SANDRA B. DECOSTA

DIVISION OF EDUCATION
604 ALLEN HALL
WEST VIRGINIA UNIVERSITY
MORGANTOWN, W. VA. 26506-6122

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Teacher Thinking: Effects of Intervention Instruction on Basic Teaching and Problem Solving Skills

Research on expert-novice differences in is useful from a teacher education viewpoint because it provides descriptions of possible differences in the cognitive structure of teachers. Expert and novice are not distinct categories, but rather imprecise positions along a continuum from little to extensive knowledge, both declarative and procedural. Thus, uninstructed, novice and expert have been described as 3 points on this continuum (Champagne, Gunstone and Klopfer, 1985). Uninstructed individuals have knowledge needed in the teacher education domain only through personal experience and everyday learning. This knowledge comes from participation in educational contexts, most recent having the highest impact, and statements that are made about teaching. A novice has some additional organized experiences and knowledge of the variables related to education practice. An expert incorporates the knowledge structure of the domain that is corsistent with and encompasses public knowledge of the domain and can flexibly apply that knowledge to a variety of situations within the domain.

That there is a continuum between the uninstructed and expert teacher can be illustrated by differences noted from a variety of fields. A summary of skills from cognitive psychology literature define experts, in terms of mastery and expertise, as pcssessing more information (facts and patterns), conceptualize more asbstractly, operate semantically rather then episodically, construct more complex cognitive schema, operate more quickly, demonstrate more cognitive routines and control processes, think more flexibly, manifest more cognitive chunking and demonstrate clear superiority in achieving criterion (Follman, 1985). Indeed, as a numerical estimate from different fields, Follman suggested mastery results from about ten years of practice of about ten hours a day or development of 50,000 chunks or of knowledge. These groups of knowledge include psychological information principles including mnemonics of mental images and sentences, grouping, ordering, hierarchies, and rehersal strategies.

Expert-novice teacher research literature has also attempted to identify differences of "expert" teachers from other teachers. Individual reports include performance employed, equally proficient action schema and information schema (Leinhardt and Greens, 1984); focus on individual student performance rather than only the entire class, made more information requests, anticipated possible situations, generated contingency plans, made more instructional descriptions in the area of management, assessed feedback received, focused attention, concerned with managing activi'ies during instruction (Housner and Griffey, 1985); make inferences, use higher orders of categorization, exhibit fast pattern recognition and represent problems differntly than novices (Berliner, 1986). In summary, common characteristics of experts include the following areas, possession of large amounts of information and knowledge, automatization of congitive processes (especially routines)

success in achieving criteria, higher levels of abstraction, construction of complex schema, speed of activity, cognitive flexibility and chunking (Lavely et. al. 1987).

Teaching performance routinely and frequently requires decisions to be made in a problem solving context, about 1 decision every 2 minutes throughout the school day (Clark and Peterson, 1985). The information from expert-novice differences implicate teacher decision making in solving problems, both from specific and general knowledge possessed, and thought processes used. These areas can be represented as a conceptual structure, a set of cognitive mediating links which produce a relatively stable set of techniques by which an individual receives, processes and transmits information. The characteristics of an individual's conceptual structure are determined by the complexity of the cognitive mediating links with which he maps his environment and generates courses of action (Sieber, 1964). This structure determines the kinds of information a person seeks, organizes and generates. The teacher's conceptual structure appears to be a factor related to performance differences between expert and novice teachers.

Conceptual structure is not the sole determinent of decision making complexity. The complexity of the decision making situation or problem uncertainty itself plays a large role in determining the nature of the teachers' thought and actions. Simple situations with low problem uncertainty contain too little information to require complex processing. One would note little differnce between expert and novice performance. Complex environments contain too much information to integrate meaningfully, a high problem uncertainty. Environemntal complexity and conceptual structure iteract. This interaction results in different performance levels between individuals. Expert teachers with a higher conceptual structure, as evidenced by expert characteristics, will demonstrate greater and more complex differences from novices in ability to acquire relevant information, process it and generate new information.

The classroom has been described as a complex environment, by a number of researchers, which results in the demonstrated inability of uninstructed and novice teachers to be aware of classroom events and be successful in solving problems. Three dimensions used to describe this complexity include multidimensionality of tasks, objects, and events; simultaneity of happenings; immediacy of events and unpredicatability of performance based on number and types of variables present. (Doyle, 1986)

Sieber (1964) reported that teachers with higher cognitive structure or complexity have been found to demonstrate greater information acquisition and search behaviors than less complex individuals as the environmental complexity of problem situations increased. The same increase was found with the amount of new information generated. The expert-novice continuium, thus, interacts with the problem uncertainty level. Although many expert characteristics may require significant time for development, at least one area may be acessable for

direct development through specific instruction. This characteristic involves the encoding process and its impact on performance in planning for and using appropriate teaching behavior, rehersal, elaboration, organization and manitoring strategies (Weistein and Mayer, 1986). This encoding process includes selection of information and storage in short term memory, acquisition of information by transfer from working memory to long term memory, construction of connections between information and forming categories holding and relating information together and integration of new information with old knowledge in the working memory to develop explanations and outlines for future action. For such specific teaching activities as planning and performance analysis, lesson planning, and classroom teaching where the encoding process is used in decision making to solve problems (hypothetical -deductive reasoning), deficiencies in these processes could involve performance in at least nine areas.

1. Unrecognized need for or perception of clear and discrete sensory data allowing for appropriate distinction of instructional or classroom objects, events, or interactions (**Clear Data**).
2. Unrecognized need for perception or reporting of all data in relevant instructional variables. All of the data may not be perceived causing unrealistic approximations and inadaquate descriptions to be made (**Sufficient Data**).
3. Lack of need and ability to obtain a wide range of precise data using different kinds of instructional data sources to describe relevant variables (**Data Sources**).
4. No organized approach in obtaining instructional data or to determine those types relevant to the goal or problem at hand. Frequently, planning responses are made incorporating only part of the data (**Exploratory organization**).
5. Lack of need and ability e-ectively store or to retrieve all classroom and student obs rvations from memory (**Retrieval**).
6. Lack of sufficient questions to guide acquisition of instructional data source information (**Questions**).
7. Lack of need or ability to use different types of investigative strategies appropriate in obtaining instructional data (**Types of Questions**).
8. Lack of ability to select relevant cues in defining an instructional problem. Hypothesis testing which is based on this process would be impaired due to the lack of discrimination of cues to be tested (**Cue Discrimination**).
9. Inability or lack of need to use hypothetical-deductive reasoning or methods of hypothesis testing. Trial and error planning and teaching behaviors occur along with an inability to make appropriate use of the experences. If instructional or classroom problem cues are perceived as being discontinuous or discordant, ineffective attempts are made to process the information further. Alternative hypotheses are not made to put the cues in context with other data. No mental or trial testing is seen as necessary to check the validity of hypotheses, if they are given, or the relationship of cues to each other (**Hypothesizing**).

The order of the basic encoding processes offer one answer to the questions of why novice teachers may not exhibit appropriate behaviors in classroom settings even though they may be able to demonstrate appropriate behavior when asked to do so in a test setting. Shavelson and Stern (1981), and subsequently others, have suggested a model of a teacher as decision maker to explain the exhibition of particular teaching behaviors to be performed during teaching. This model posits that as the teacher carries out routines he/she observes the classroom for cues to determine if actions are to be initiated, sustained, modified or terminated. The results of a variety of studies suggest that cue acquisition as well as decision making outcomes and other encoding processes do not occur similarly across teachers. How or even whether the steps in the Shavelson and Stern decision making process are undertaken appears to depend at least in part, on the ability of the novice teacher to process very complicated sets of cues (Copeland, 1987). It has been demonstrated that intensive instruction in cue attendance can improve uninstructed teachers' problem solving skills on science type problems (Wright, 1979 and 1988) and novice teachers' performance on specific lesson planning and classroom teaching performance (Sunal, 1988a and 1988b and Demchik and Sunal, 1987). Additional research has implicated novice teachers' cognitive structure as a factor in problem solving in general (Inhelder and Praget, 1958) and in quality of planning and classroom teaching performance (Sunal, 1980b; Sunal and Sunal, 1985; and Garnett and Tobin, 1984)

Problem

This investigation was designed to take the research process one step further. The purpose of this study was to determine if intervention instruction in encoding processes effects novice teacher problem solving ability in educational contexts of varying levels of complexity. The problem investigated was to determine the effects of intervention training in nine specific encoding processes, prerequisite to effective problem solving, on novice teacher performance in observing and describing lesson cues, asking questions and making decisions in solving simulated and real educational problems and making higher quality decisions in planning and teaching classroom content lessons. In addition to levels of environmental complexity, the cognitive structure level of the novice teacher was also studied to determine its effects on the quality of the professional performance. The following research questions were examined on the effects of type of intervention instruction. Subscripted letters refer to measurements reported on table I.

1) Does intervention instruction in basic encoding processes effect cue acquisition in lesson plan and teaching evaluation ($O_{5,7,8}$)?
2) Does intervention instruction in basic encoding processes effect the construction of lesson plans designed for actual classroom teaching (O_9)?

3) Does intervention instruction in basic encoding processes effect quality of decision making in simulated and actual planning and teaching situations ($O_{6,9,10}$)
4) What effect does the conceptual level ability of the novice teacher have on performance using encoding processes and decision making in planning and teaching.
5) What effect does the conceptual complexity of the environment have on use of encoding processes and decision making in planning and teaching performance.

PROCEDURE

Research Design

An experimental pre-posttest research design was used to test the research questions. The sample was randomly chosen from the population of subjects and assigned to two treatment groups. Each group was given the same experiences except for the intervention treatment variable. See Table I for a description of the research design. Pretesting included determination of cognitive level (O_1) of the novice teachers and classroom planning and problem solving ability (O_{2-4}). Background and context variables of subjects' experience, treatment, and classroom conditions were measured. Posttests included classroom contexts of varying levels of complexity during short and long term time periods following the treatment (O_{5-10}).

[Insert Table I Here]

Sample

The population consisted of senior year preservice education majors at a large eastern land grant university. The home backgrounds were diverse, from rural to urban. The participants majored in early and middle childhood education in grades K-8. The teacher education program was field oriented, beginning with class visits in the sophomore year and ending with teaching assignments in classrooms during the entire last year. Thirty sample subjects, novice teachers, participated in the study in the semester before student teaching. During this time subjects were registered in a full load, common block of courses; social studies, mathematics, reading, science and general methods. They spent 40% of their time performing a variety of tasks and teaching in assigned school classrooms.

Treatment

Two treatment groups were formed. The control group received instruction in lesson planning and curriculum evaluation in four sessions covering three weeks. They were instructed in basic skills in writing and analysis of lesson plans and teaching from lesson plans in classrooms. This included modeling, use of materials and classroom management skills in each of the five courses they were enrolled in. An additional four hours of intervention instruction in analysis

involved determination of lesson plans' potential goals and problems, matching materials to an appropriate group of target pupils, and modification of the lesson plans for most effective learning. The control teachers worked a total of 16 hours on these tasks. Feedback on work was provided during and at the end of the sessions.

The experimental group, except for the additional four hours, received the same instruction over the same period of time. The additional four hours of intervention instruction involved, instead, direct intervention instruction in nine encoding processes in an individualized format. These involved the nine encoding process skills listed above. Treatment effects were measured in these nine in addition to additional, more global, variables all related to a classroom teaching context. See table II for a listing of the variables and the sequence of observations made during the study. The variables all dealt with far-transfer effects of the intervention instruction. Previous research had found significant near-transfer effects in situations similar to those in which the novice teachers were originally instructed (Sunal, 1988a and Wright, 1979 and 1988). Research assistants used in the instruction and classroom observations were individually trained according to specific intervention instruction procedures established as reliable and valid in previous studies (Salomon and Sieber, 1970 and Wright, 1977).

The experimental group intervention involved three separate weekly sessions. The first session, cue attendance instruction (CA), provided experience in encoding process behaviors which included the first five previously described encoding processes, clear data to retrieval. The experimental group subjects during the intervention instruction were requested to describe a difficult criterion level of relevant details potentially useful in resolving a complex problem shown to them. The filmed problem was one of Richard Suchman's (1966) Inquiry Development Program filmloops published by Science Research Associates as described and used in previous research performed by Wright (1978). The film consisting of discrepant events centered on a physical problem was selected because of its abstractness.

The instruction began with introductory remarks regarding the nature and purpose of the task. An example of the activity was performed by the session instructor using a second Suchman filmloop, "The Knife". Then subjects were asked to observe and remember as many cues as possible during the showing of the second 2 1/2 minute film, "The Balloon in the Jar". Cues were reported and recorded from subjects only at the end of each showing. This was done until the subjects exhausted the number of cues seen and remembered. Repeated showings added details of cues observed to the original list. The film was shown as many times as required for the subjects to obtain the necessary criterion number of details. The subjects were instructed not to attempt to explain why events were happening in the film or to give a response which could not be observed directly in the film. Duplicate and non-observable details reported were

written down but not counted. Appropriate responses were reinforced.

The last two intervention sessions given to the experimental group were designed to provive additional practice in the first five encoding processes and instruction in the remaining four encoding processes. The sessions involved viewing one additional Suchman Inquiry Development Program filmloop for each session. The films were titled "Pendulum" and "Sailboat." After viewing, the subjects were asked to state as many questions (questioning session, Q) or hypotheses (hypothesis generation session, HG) as they could about the problems they had seen on the film. Following Robert Suchman's (1966b) questioning strategy the subjects were asked to state questions about the first filmloop which ask only for known facts, not inferences or conclusions. Using procedures developed by Quinn (1971) and Salomon (1968), subjects were also requested to give as many alternative hypotheses (explanations) as possible to explain what was seen in the film. A response example was given for each of the film problems. The novice teacher was shown the filmloop as many times as needed to develop their responses. All subject responses were individually recorded and encouraging feedback given. Only appropriate responses were counted.

Instruments

Pre-treatment measures, which were given at the beginning of the methods courses, consisted of determination of subjects' level of cognitive functioning, planning a classroom lesson, analysis of a prewritten lesson plan, and solving a classroom problem in a computer simulation. See table I for a list and sequence of the instruments used during the study. The "Reasoning Task", RT, (Shayer and Adey, 1979) pretest was given to groups of five through live demonstration. The specific task used was the Equilibrium in the Balance. This task involved use of inverse proportions in 13 situations varying in complexity from Piagetian levels 2A to 3B. The internal consistency of the task has been reported at 0.84 and test-retest correlation at 0.78 (Shayer and Adey, 1979). Subjects wrote responses to questions and a rationale for each answer as described by Shayer and Adey. The cognitive functioning level was determined from the score obtained on RT for each subject.

The "Recognizing Lesson Plan Details" (LPD-1) pretest asked novice teachers to review and analyze a prewritten lesson plan to provide a brief evaluation of the quality of the plan. The lesson plan was taken up when the teachers reported that they had reviewed the lesson thouroughly. They were then asked to describe as many details of the plan as they could remember, whether useful to the evaluation or not and finally to rate the lesson on a five point likert scale. They were given five minutes to complete the task. The short time was an attempt to simulate, somewhat, ad-lib decision making in everday teaching. A higher number of cues were assumed to correlate with a greater number of alternative hypotheses formed.

The novice teachers were also asked to solve a classroom management problem individually by making a series of decisions, chosen from a set of alternative actions possibie, in an interactive computer simulation, "Solving Classroom Problems" (CP-1). The problem "Letter" was one of a series of problems in "School Transactions" computer simulation package (Lunetta, 1984). This was done to determine the quality level of decisions made. The final pretest involved writing of a lesson plan on a specific assigned topic. The final pretest, "Critical Lesson Plan Components (CLPC), was administered to determine the extent of novice teachers' performance in sequencing and inclusion of all necessary components of a lesson plan.

Completion of posttests involved short and long term, far-transfer effects in all nine encoding process areas and seven teaching performance areas. A description of the dependent variables and time sequence of measurement can be found on table II. Three posttests, given between seven and ten days after the intervention instruction was completed, included new versions of two of the pretests and a lesson observation. "Recognizing Lesson Plan Details" (LPD-2) and "Solving Classroom Problems" (CP-2) each used different problems, a different 'esson plan and the computer simulation, "Fight" (Lunetta, 1984), requiring decision making. "Recognizing Classroom Details on Videotape" (TAPE-2A) posttest involved viewing a five minute portion of a classroom lesson on video tape. Study subjects were asked to view and evaluate the lesson at the end. Before evaluating the lesson on a five point likert scale the novice teachers were asked to describe as many relevant details they could remember that were potentially useful in understanding the events occuring in the lesson, whether they were useful in making the evaluation or not. They were asked to describe as many details as possible in a five minute time period. This was done again to simulate everyday decision making in a class setting.

The observation "Classroom Lesson Planning and Teaching" (LESSON-2A) evaluated subjects lesson plans and teaching in their assigned classroom in schools three weeks after the the intervention treatment. The lesson was to be an experiential science activity designed to teach science process skills (Kauchek and Eggan, 1980). The lesson type was studied, experienced and modeled during the methods courses taught on campus. The teachers were assigned to schools for three weeks during this period without returning for instruction on campus. Teaching of pupils using this lesson plan occured during the third week. Following teaching, all novice teachers submitted the lesson plan, pupil evaluation results, and pupil work sheets for evaluation of amount of details given, type of questions asked and a rating using the modified form of the Microteaching Skills Rating System (MSRS). A description, including reliability and validity measures, of the instrument has been reported in previous studies (Sunal, 1978, 1980a, and 1982). The MSRS System had eight subparts, with a total of 40 items, evaluating the lesson plan, classroom management, questioning, student learning activity, lesson clarity, and student evaluation. The MSRS includes evaluation of teaching by direct observation in the classroom and evaluation of materials used in

planning and teaching the lesson. A narrative evaluation and a numerical score ranging from 1 to 5 and averaged for a total score was obtained which reflected quality of planning and teaching. Three field observers evaluated and rated both the lesson plan materials and the teaching of the lesson in classrooms. All lessons were jointly evaluated and rated by two observers. Observer inter-rater correlations averaged 0.87 for the group of teachers.

Six weeks after the treatment, the novice teachers were askea to observe and evaluate a second videotaped lesson, "Recognizing Classroom Problems" (TAPE-2B). The teacher involved in the taped lesson demonstrated appropriate and inappropriate teaching behaviors common to those seen with novice teachers. Inappropriate behaviors on the 15 minute tape involved the areas of lesson sequence, discipline, and classroom management (Mertens and Bramble, 1977). Following viewing of the tape, the teachers were asked to describe and evaluate the lesson citing all areas for concern. They were asked to cite as much evidence as possible from the tape supporting each area of concern. All responses were recorded and the teachers were given as much time as needed. The emphasis here was to determine if increases in encoding process ability were related to a greater amount of cue acquisition and a greater number of alternative hypotheses.

The final posttest was administered to determine treatment transfer effects in a long term test situation. The "Classroom Unit Planning and Teaching" (Lesson-2B) posttest was given ten weeks after the last intervention treatment session. The observation was designed to provide an overall quality measure of the effect of higher level encoding skills on teaching variables. This posttest, using the MSRS observational rating system, described above, evaluated the planning and teaching of a three lesson content unit to children taught previously. This activity occured during the second three week contact in novice teachers' assigned classrooms. During this time the teachers did not return to campus for instruction. The lessons concerned consecutive lessons to be given on three separate days and was to be modeled after one of the instructional approaches suggested by Kauchek and Eggan (1980). The instructional approaches were studied, experienced, and modeled in the methods course sessions occuring before the unit was to be taught. The lesson plan forms required statements on the goal, objectives, procedures, and student evaluation for each lesson. Subjects were observed and rated in classroom teaching of the lessons by the previous field observers. Bridging, discussion of the importance of using the encoding processes in planning and teaching activities, was done in clinical supervision conferences by the observers during the weeks teachers were in their assigned schools, a total of six visitations. All lesson plans, audiotapes of lessons, and pupil papers and records were turned in for an overall evaluation and rating.

[Insert Table II Here]

Analysis

The data from the instruments were coded following sequences described in previous instrument source articles and research studies. Shayer and Adey (1979) and Sunal (1978, 1980a and 1982) described reliable and valid procedures for interpreting responses and observing performance. Wright (1975) described procedures for counting details, questions, and hypotheses. Content differences in statements were added to the counting procedure.

Categories of questions given by the subjects were also analyzed, as described by Suchman (1966), to determine the diversity in the types of inquiry patterns used. This was done in order to determine changes which might have taken place in information acquisition. Suchman defined different types of inquiry patterns each based on the kind of data used as an information source. The kinds of data involve, Events, Objects, Conditions, and Properties.

Multiple and univariate analyses of variance were used to assess the equivalency of groups. Post-hoc testing, using the Tukey test procedure, was used to determine the source of the significance when necessary. The level of significance accepted in all analyses was 0.05.

RESULTS

Pretreatment measures included assessment of background variables, pretesting of lesson plan analysis and classroom decision making, and level of cognitive complexity. Study participant groups did not differ significantly in their backgrounds, see table III. They had a mean GPA for all previous courses of 2.85, on a 4 point scale, gave moderately positive ratings to content foundation courses taken, and taught in assigned classrooms where the ability level of the pupils was average. Both groups performed on average at the transitional level between concrete and formal reasoning on the Reasoning Tasks. A rating of 2 has been determined as concrete, 3-4 as transitional and 5-6 as formal (Shayer and Adey, 1979). No significant statistical differences were found in the pretests between the groups, as shown in table IV and V. As a result of the reasoning task, two novice teachers were rated as concrete, 2B, three as early transitional, and four as late transitional 2B/3A. In addition, 15 novice teachers were rated as early formal, 3A, and six as late formal 3B.

An attempt was made to validate hypothesized differences between novice and expert teachers in the computer simulation of solving classroom management problems, (CP-1,2). Five early and middle childhood teachers, with eight or more years of experience were identified as exceptional classroom teachers. Their performance on the simulation was near perfect. One teacher was rated five, the rest 6, for an overall mean of 5.8. This occured on both the pre and post simulations.

[Insert Table III Here]

Research Question 1: Cue acquisition and decision making effects ($O_{5,7,8}$)

The posttest results on cue acquisition behavior with lesson plans, LPD-2 (O_5), and classroom teaching, TAPE-2A (O_7) were significantly different $F = 32.44$ at $P<.01$ and $F = 21.68$ at $P<.01$ respectively. Summary statistics are shown on table IV. Experimental novice teachers were able to describe 85% more lesson plan details and 43% more observed classroom lesson details in the same contexts as the control teachers. The experimental teachers had acquired more details to support their evaluation and a possible greater number of alternative hypotheses about the lesson plan and classroom teaching quality. The difference between groups did not occur in the pretest situation. The control group did not improve upon the level of cue acquisition in support of evaluating lesson plans from the pretest. Both groups described more det-ils as a result of the tape observation compared to the lesson plan observation.

In post-posttest, TAPE-2B, experimental instructed teachers reported a greater number of alternative hypotheses, 25%, and supporting details, 107%, than control teachers for an evaluation with a taped classroom lesson. Only the supporting details difference was significant $F = 17.0$, $P\leq.01$.

Research Question 2: Decision making in classroom teaching performance (O_9)

Experimental teachers in a school setting, LESSON-2A, wrote lesson plans when requested, for subsequent classroom teaching, with 41% greater amount of detail than control teachers. This was a significant difference, $F = 8.39$, $p\leq.01$ and similar in result to previous campus based observational measures, $O_{5,7,8}$. Classroom management details given in the lesson plans were specificantly counted. The experimental teachers wrote 112% more details about managing students and classrooms than control teachers, $F = 5.74$, $p\leq.02$. The questions asked by the teachers in conducting their lesson in the classroom w re significantly different between the two groups, $F = 8.46$, $p\leq.01$. The experimental novice teachers, having had a treatment session focusing on questionning as a means to gain information in understanding problems, asked more questions and different types of questions. They asked more in all four areas as described by Suchman, and significantly more questions concerning data sources dealing with events and properties.

Research Question 3: Quality of decision making in classroom teaching performance ($O_{6,9,10}$)

In order to determine the effect of the treatment difference on quality of decisions made, simulated and actual problems were used. In the computer simulation, CP-2, various decision paths were rated according to their potential of creating desirable outcomes in problems presented to the teachers. Experimental teacher reactions to the computer simulation resulted in 19% higher, although not significantly

different, $F = 3.34$, $p \leq .07$, ratings than the control teachers. The groups were not different in making higher quality decisions in either the pre or posttest situations.

Observations were conducted of novice teachers' lessons taught three weeks, LESSON-2A, and 10 weeks, LESSON-2B, after the last treatment session. Quality of decision making was evaluated in constructing lesson plans and classroom teaching in schools. Overall evaluation of the lessons using the MSRS observational system resulted in significantly higher ratings of experimental teachers' lesson plans at three weeks, 14%, $F = 10.68$, $p < .01$, and at ten weeks, 8%, $F = 4.46$, $p = .04$. Overall the teaching performance, rated with the MSRS observational system, of bot! groups were not significantly different, $F = 0.19$, $P = .66$ an $F = 0.79$, $P = .38$, respectively. Overall, final methods course grade average was also not significantly different, see table IV. In both teaching performance and final grade, experimental teachers received a higher average than control students.

Research Question 4: Effect of conceptual level ability on performance ($O_{1,9,10}$)

Novice teachers, with higher conceptual structure level as rated by the Shayer and Adey instrument (1979), RT, gave more details and made higher quality decisions in tasks concerning actual planning and teaching classroom performance. Summary statistics are shown on Table V. An analysis of variance procedure was used with group, control and experimental, and cognitive structure, split into two equal groups, as independent variables. Higher cognitive level teachers performed significantly better on LESSON-2A amount of details given, $F = 5.5$, $p=.02$, and quality of lesson planning, $F = 7.9$, $p \leq .01$. They also were observed as higher quality in their teaching performance in LESSON-2B, $F = 7.9$, $p \leq .01$, and overall for their planning and teaching, LESSON-2B total rating, $F = 5.1$, $p=.03$.

Higher cognitive structure did not affect performance as measured by other posttest instruments used in the study. One result of interest was a significant difference due to cognitive structure in the amount of details used in evaluating a lesson plan, LPD-1, pretest. Following the treatment, cognitive structure was not related to a difference in performance among experimental teachers. The effect of the experimental intervention was enough to create an equally higher capacity in use of encoding skills and decision-making in lower cognitive structure experimental teachers.

Research Question 5: Effect of conceptual complexity of the environment on performance O_{5-10}.

Conceptual complexity of the environment in this study was defined by the type of environment problem solving was to occur in. Multidimensionality, simultaneity, immediacy, and unpredictability of objects, variables and events varied among the problem situations given to the novice teachers. The simulated environments were judged to have less conceptual

complexity and planning for lessons less complexity than teaching lessons. Using this criteria, the following environments were judged very complex,

Lesson-2B Teaching and
Lesson-2A Teaching;

moderately complex environments,

Lesson-2B Planning and
Lesson-2A Planning, questionning, and management details;

and less complex environments,

CP-1,2,
CLPC
LPD-1,2,
TAPE-2B,
TAPE-2A.

Using Table V as a reference, higher cognitive level teachers performed significantly better in use of encoding skills and decision making in only the very and moderately complex environments. Their performance was not different from lower cognitive level teachers in less complex environments as defined above. Although experimental intervention instruction was able to significantly make up the difference in less complex environments, the difference although present was less obvious in more complex environments. Information acquisition and use in decision making in classroom lesson planning in Lesson-2A and in classroom teaching in Lesson-2B increased with cognitive level.

[Insert Tables IV an V Here]

CONCLUSION AND SUMMARY

The reported results support the following conclusions for the five research questions around which the study was designed.

Research Question 1: Intervention instruction in encoding processes create greater cue acquisition during evaluation of prewritten lesson plans and classroom teaching performance. This relates to enhancement of increased encoding processing ability in the first five encoding processes, clear data, sufficient data, data sources, exploratory organization and retrieval.

Research Question 2: Intervention instruction in encoding processes does affect lesson plan construction by increasing the number of details described in the lesson plan and the number and type of questions asked of pupils during the lesson. Enhancement of increased ability to use encoding processes found in research question 1 also relates to the writing of lesson plans. These results are in agreement with results found by Demchik and Sunal (1987). The increased details provide support

for the idea that in solving problems addressed by the writing of a lesson plan, experimental novice teachers 1) developed a greater need to include more and sufficient details, 2) used a greater number of data sources for pupils in developing the lesson, 3) retrieved a greater amount of information for the classroom setting and 4) developed a greater information base from which alternative hypotheses could be developed in proposing a solution. These skills relate to all nine processes involved in the treatment.

Research Question 3: Intervention instruction in encoding processes increases the quality of decision making in constructing lesson plans to be actually taught in classrooms. The quality of decision making in simulated and real teaching situations was not significantly different from control novice teachers. The results of decision making performance using computer simulations, CP-2, need further explanation. The CP-2 scale range, 1-6, and the lack of details provided may have resulted in low differentiation of differences in encoding process ability. Many, almost 1/2 of the teachers, were responding in the highest quality decision sequence on the pretest. Details for each decision, alternatives to choose from, were restricted to one full screen on the computer monitor. Details for each alternative were few in number. Additional details had to be recalled from the teacher's past experiences, if more were desired.

Research Question 4: Conceptual structure level affects novice teacher performance in actual classroom teaching situations. The difference was significant in both planning and teaching of lessons, although not consistently so. These results are in agreement with (Sunal 1980, 1988a, and Sunal and Sunal, 1985). Higher cognitive structure novice teachers use more encoding processes and make decisions more effectively in teaching situations in school classrooms. In many of the observations, the importance of higher cognitive structure is mediated and at times equalled by experience with the experimental intervention treatment. This was noted with simulated tasks involving use of encoding processes and planning lessons involving decision making. Higher cognitive structure was more important than treatment differences when quality of decision making was observed in classroom teaching performance.

Research Question 5: The use of encoding processes and decision making in planning and teaching performance varied with the complexity of the environment. This environmental complexity resulted in demonstrated inability of novice teachers to be aware of classroom events and be successful in solving problems in some situations. These results support the previous work of Doyle (1986) and Seiber (1964) and Sunal and Sunal (1985). The novice - expert continuum interacts with problem uncertainty level. There was an interaction between conceptual structure and uncertainty such that the greater the uncertainty of a choice, the greater the differences between novice teachers of low and high cognitive structure. Higher cognitive level teachers increased in amount of search for information, cue

acquisition, as problem uncertainty increased. Lower cognitive level teachers did not.

Implications

Overall, experimental intervention instruction in encoding processes was effective in changing basic teaching and problem solving skills for the novice teachers. In addition, the cognitive structure of the novice teacher was important and positive in enhancing skill performance. The environmental complexity of the setting added an additional factor. It increased differences between novice teachers of low and high ability. Taken together these three factors are important in determining the effectiveness of teaching in a specific classroom setting. The overriding factor relates to the complexity of the environment. The classroom is a very complex environment which creates low level performance in less experienced and lower cognitive level teachers.

Enhancement of teacher encoding processes and decision making skills can have an important positive effect on teaching performance and helps moderate differences of teachers with varying levels of cognitive structure and experience. The purpose of the experimental intervention instruction was to overcome deficiencies novice teachers may have in encoding processes, to facilitate their efficient use, and to make their use more consistent in making decisions to more effectively solve educational problems. Performance characteristics of the experimental novice teachers became more like expert teachers in general and specific areas. For example, experimental novice teachers in this study sought more information, anticipated a larger number of possible situations, and made more instructional descriptions in the area of management (Housner and Griffey, 1985); exhibited faster pattern recognition (Berliner, 1986) and exhibited greater speed of activity and success in achieving criteria (Lavely et. al.,1987 and Leinhardt and Greens, 1984).

This study supports the hypothesis that teacher education courses and inservice training focusing at least partially on basic encoding processes can increase uninstructed and novice teacher effectiveness in basic teaching and problem solving skills. Additional instruction in education methods and content alone, the control treatment, was less effective than intervention instruction in moving novice teachers' performance in making decisions toward levels attained by expert teachers.

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Table I

Research Design

Groups	Activity			
	Pretests	Treatment	Posttests	Post-Posttest
Control n = 15	0_1 0_2 0_3 0_4	x_1	0_5 0_6 0_7	0_8 0_9 0_{10}
Experimental n = 15	0_1 0_2 0_3 0_4	$x_{2\text{-}1,2,3}$	0_5 0_6 0_7	0_8 0_9 0_{10}

Total n = 30

x_1 Intervention instruction a) analysis and modification of classroom lesson plans (X_1) and b) a three phase process of instruction in information processing skills (X_2); ($X_{2\text{-}1}$) Instruction in cue attendance (CA), ($X_{2\text{-}2}$) Instruction in questioning to identify relevant variables in a problem situations (Q), ($X_{2\text{-}3}$) Instruction in hypothesis generation in a problem situation (HG).

Pre Tests -

0_1	Reasoning Task (RT)
0_2	Recognizing Lesson Plan Details (LPD - 1)
0_3	Solving Classroom Problems (CP - 1)
0_4	Critical Lesson Plan Components (CLPC)

Posttests

0_5	Recognizing Lesson Plan Details (LPD -2)
0_6	Solving Classroom Problems (CP -2)
0_7	Recognizing Classroom Details on Videotape (TAPE - 2A)

Post-Posttests

0_8	Recognizing Classroom Problems on Videotape (TAPE - 2B)
0_9	Classroom Lesson Planning and Teaching (LESSON - 2A)
0_{10}	Classroom Unit Planning and Teaching (LESSON - 2B)

Table II
Variable Measurement

Variables	Observations			
	Pretest	Treatment	Posttest	Post-Posttest
A. Encoding Processes				
1. Clear Data	O_2 O_4	$X_{2\text{-}1}$	O_5 O_7	O_8 O_9
2. Sufficient Data	O_2 O_4	$X_{2\text{-}1}$	O_5 O_7	O_8 O_9
3. Data Sources	O_3 O_4	$X_{2\text{-}1}$	O_7	O_8 O_9
4. Exploration	O_4	$X_{2\text{-}1}$	O_7	O_8 O_9
5. Retrieval	O_2 O_4	$X_{2\text{-}1}$	O_5 O_7	O_8 O_9
6. Questionning	O_3	$X_{2\text{-}2}$	O_6	O_9
7. Types of Questions		$X_{2\text{-}2}$		O_9
8. Cue Discrimination	O_3	$X_{2\text{-}3}$	O_6	O_8 O_9 O_{10}
9. Hypothesis Generation	O_3	$X_{2\text{-}3}$	O_6	O_8 O_9 O_{10}
B. Cognitive Development Level				
1. Reasoning Ability	O_1			
C. Teaching Variables				
1. Recognizing Lesson Plan Details	O_2		O_5	
2. Including Critical Planning and Teaching Components	O_4			O_8
3. Solving Classroom Problems	O_3		O_6	
4. Recognizing Classroom Details			O_7	
5. Recognizing Classroom Problems				O_8
6. Lesson Planning and Teaching				O_9
7. Unit Planning and Teaching				O_{10}

Table III

Summary Statistics of Independent Variables

Variable	Control Instruction Group Mean (Std. Error)	Experimental Instruction Group Mean (Std. Error)
Grade point average	2.86 (0.11)	2.84 (0.12)
Rating of content courses taken at the university (1-5)	3.64 (0.30)	3.77 (0.32)
Ability level of students in assigned classroom (1-5)	2.91 (0.38)	2.79 (0.35)
Reasoning Task Score (0_1)	4.7 (0.32)	4.5 (0.32)
Reasoning Level (RT)	2.8 (0.20)	2.8 (0.22)
Piagetian Level (2B, 2B/3A, 3A, 3B; 1-4)	2B/3A	2B/3A

Table IV

Summary Statistics for Dependent Variables by Treatment Group

Variable	Treatment Groups: Control Mean (Std. Error)		Experimental Mean (Std. Error)		F. Value	Probability
Posttests						
Recognizing Lesson Plan Details (LPD-1,2)						
a) Pretest, 0_2	8.1	(0.66)	7.8	(0.61)	0.55	.47
b) Posttest, 0_5	7.8	(0.58)	14.4	(1.00)	32.44**	.01
Solving Classroom Problems (CP-1,2)						
a) Pretest, 0_3	4.9	(0.42)	4.5	(0.40)	0.54	.45
b) Posttest, 0_6	4.8	(0.44)	5.7	(0.21)	3.17	.08
Including Critical Plan Components (CLPC) Pretest Only, 0_4	6.1	(0.25)	5.7	(0.37)	0.56	.46
Recognizing Classroom Details (TAPE -2A) Posttest only						
a) Total Details, 0_7	14.9	(0.88)	21.3	(1.1)	21.68**	.00
b) Details about, Students and Teacher 0_{7-1}	11.9	(0.87)	15.8	(0.90)	0.10	.75
c) Classroom Details, 0_{7-2}	2.9	(0.37)	5.5	(1.10)	5.51*	.03

Table IV (Continued)

Summary Statistics for Dependent Variables by Treatment Group

Variable	Treatment Group Control Mean (Std. Error)	Experimental Mean (Std. Error)	F. Value	Probability
Post-Posttests Only				
Recognizing Classroom Problems (TAPE-2B)				
a) Component areas identified, 08-1	6.0 (0.61)	8.0 (0.75)	3.40	.07
b) Details cited as evidence, 08-2	4.3 (0.59)	8.5 (0.76)	17.00	.00
Lesson (LESSON - 2A)				
Details included in plan, 09-1	15.6 (1.10)	21.9 (1.86)	8.39**	.01
Questions Asked Total, 09-2	1.9 (0.64)	4.1 (0.45)	8.46**	.01
Class Management Details Given, 09-3	2.5 (0.52)	5.3 (1.04)	5.74*	.02
Overall Plan Quality, 09-4	73 (2.32)	83 (2.00)	10.68**	.00
Overall Teaching Quality, 09-5	78 (2.41)	80 (1.82)	0.19	.66
Unit (LESSON - 2B)				
Overall Plan Quality, 010-1	75 (2.06)	81 (1.51)	4.46*	.04
Overall Teaching	82 (1.32)	82 (1.63)	0.79	.38
Methods Course Grade Average	70 (1.79)	74 (1.71)	1.54	.23
Methods Course Exam Average	71 (1.70)	70 (2.04)	.01	.98

Table V

Summary Statistics for Dependent Variables by Cognitive Structure Level of Novice Teachers

Selected Variable	Novice Teacher Groups		F-Value		
	Low Structure	High Structure	Main Effect	Group	Cognitive Level
Recognizing Lesson Plan Details (LPD - 1,2)					
a) Pretest					
Control	6.0	9.56			
Experimental	6.1	9.6	5.4*	1.6	10.1**
b) Posttest					
Control	6.8	8.7			
Experimental	13.6	15.3	15.9**	31.7**	0.5
Recognizing Classroom Details (TAPE - 2A)					
Control	16.0	14.1			
Experimental	21.5	21.1	10.7**	19.5**	0.6
Recognizing Classroom Problems (TAPE - 2B)					
a) Component areas Identified					
Control	6.7	7.3			
Experimental	7.4	8.7	0.8	1.0	0.9
b) Details cited as evidence					
Control	4.0	4.6			
Experimental	7.9	9.1	8.6**	17.0**	0.8

* significant at the $p \leq .05$ level
** significant at the $p \leq .01$ level

Table V (Continued)

Summary Statistics for Dependent Variables by Cognitive Structure Level of Novice Teachers

Selected Variable	Novice Teacher Groups		F-Value		
	Low Structure	High Structure	Main Effect	Group	Cognitive Level
Solving Classroom Problems (CP-1, 2)					
a) Pretest					
Control	5.5	4.4			
Experimental	4.6	4.4	0.7	0.5	1.1
b) Posttest					
Control	5.5	4.3			
Experimental	5.4	6.0	1.8	3.1	0.3
Lesson (LESSON - 2A)					
Plan Details					
Control	13.2	17.2			
Experimental	19.3	24.9	7.5**	11.3**	5.5*
Plan Quality					
Control	67	78			
Experimental	81	86	10.7**	16.1**	7.9**
Teaching Quality					
Control	75	81			
Experimental	78	82	1.5	0.4	2.8
Unit (LESSON - 2B)					
Plan Quality					
Control	72	77			
Experimental	80	81	3.0	5.1*	1.5
Teaching Quality					
Control	80	86			
Experimental	80	84	6.1**	2.9	7.9**
Total Unit					
Control	76	82			
Experimental	80	83	2.6	0.5	5.1*

* significant at the $p \leq .05$ level
** significant at the $p \leq .01$ level